PATENT SPECIFICATION

NO DRAWINGS

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COMPLETE SPECIFICATION

Transfer Labelling

We, DIAMOND INTERNATIONAL CORPORATION, a Corporation organised under the laws of the State of Delaware, United States of America, of 733 Third Avenue, New York 17, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

In the conventional application of heat transfer labels to plastics bottles, the label is transferred to the bottle and the labelled bottle is then passed through a long curing oven to (1) remelt the web-like release coating on the label to provide a glossy finish, and (2) reheat the adhesive between the label and the bottle to insure adequate adhesion therebetween.

The present commercial practice accomplishes the adhesion between the label and the bottle by curing the labelled bottles in an oven where the temperature of the entire bottle is raised as uniformly as possible to the temperature needed for adequate label adhesion. This bottle heating, and the subsequent cooling thereof, must be closely controlled to avoid bottle distortion that will occur when sizeable temperature differentials exist within the bottle. Also, the entire bottle, when so treated, experiences shrinkage during the label curing process which normally reduces bottle volume by approximately three percent. Thus it has been necessary to decorate bottles by the application of heat transfer labels utilizing oven curing to obtain label adhesion and uniform label appearance without excessive bottle distortion. Besides the three percent bottle shrinkage, which necessitates that the original formation of the bottle by blow-molding be carried out in special over-sized bottle molds, the curing oven is costly and requires considerable floor space, and the time required to complete the labelling of any bottle is excessive. In addition, regardless of the care at which the curing oven is operated, there are inevitable malfunctions due to temperature variations, article jamming, etc. which spoil a considerable number of the labelled bottles.

The use of high temperatures in general, and direct flame in particular, for both the melting of wax-like coatings and the curing of coatings is not unknown. In addition, the treatment of polyethylene with direct flame to make the polyethylene more adhesive-receptive has been known for a number of years. However, the application of a high degree of heat over a very short time period to the outside of a freshly heat transfer labelled plastics bottle, or distortion temperature far below the applied temperature, to effect adequate label adhesion by curing the adhesive and to also effect remelting of the wax-like label surface, both effected without distortion of the plastic bottle, has not been previously contemplated.

It is therefore an object of the present invention to overcome the defects of the prior art, such as indicated above.

It is another object of the present invention to inhibit and control distortion of thermo-plastics bottles during label post-treatment.

It is another object of the present invention to provide a fast cure method for labelled plastics bottles to provide excellent label adhesion and uniform label appearance without excessive bottle shrinkage and distortion and without the need for long curing and an extended curing oven.

It is another object of the present invention to eliminate bottle shrinkage associated with oven cure, to reduce bottle spoilage due to oven cure, and to eliminate the cost

[*Price 4s. 6d.*]

and floor space needed for conventional curing ovens.

These and other objects and the nature and advantages of the present invention will be more apparent from the following description.

Regardless of the precise nature of the transfer label applied to the bottle, the freshly transferred label will have a heat-curable adhesive in contact with the plastics bottle and an upper transfer surface of wax-like character which provides the label with the desired gloss. The present method permits the fast curing which is essential to a fully automatic, in-line decorating operation and eliminates shrinkage and distortion of the decorative plastics bottles.

The case of application of the present invention depends in part upon the relative thickness of the plastics bottle and the heat transferred label. In general, the wall thickness of the plastics bottle is on the order of at least eight times the thickness of the label, including its upper wax-like coating and its bottom adhesive layer. However, this ratio of bottle thickness to label thickness may vary to as low as 4 : 1 without interferring with the process of the present invention. The greater the ratio, the easier it is to practice the present invention, since the exposure time and intensity of heat are less critical.

In accordance with the present invention, after the plastic bottle has been labelled, the label can be subjected to intense heat for such a short period of time that the bottle is not distorted. This is possible because the bottle wall thickness is great in relation to the label thickness and both the label and the plastics bottle have approximately the same thermo-conductivity. Thus, the intense heat is of such a short duration that, although the label will be quickly heated to effect curing thereof and melting of the wax-like upper surface, the heat will not be able to penetrate (i.e. by conduction) through the wall thickness of the bottle to raise the entire bottle will to its distortion temperature.

To ensure that the bottle itself does not become distorted, it is preferred to carry out, using suitable means, one or both of two additional expedients, i.e., quickly quench the bottle with cold air or water after the brief intense heating, and/or maintain a low internal gauge pressure within the bottle.

The preferred method of heat application is with direct flame, such as a natural gas flame. In such a case it is necessary only to quickly pass the labelled bottle through the direct flame which may have a temperature of 500—5000°F. However, the quick exposure to high heat may also take the form of passing the labelled bottles by a radiant heater, e.g. through an open ended radiant-heat furnace; or into a very hot fluid oven, e.g. into a hot air furnace at 600°F or more, or past a hot jet or air knife at 600°F or more which will assist in smoothing the remelted wax-like surface.

The duration of heat-treatment is critical only insofar as it is necessary not to exceed the heat distortion temperature of the plastics bottle through it entire wall thickness and, of course, a degree of flame treatment sufficiently long to melt the bottle surface would be obviously undesirable. However, on the other hand, when the outer surface of the plastics bottle adjacent the label adhesive has reached the curing temperature of such adhesive, sufficient heat has already been applied and no more is necessary. Thus, the time required to transfer the heat needed to obtain the required bottle surface temperature is dependent on the ΔT involved, i.e. the difference between the temperature at the heat source and the initial temperature of the bottle and label, and the efficiency of the heat transfer. For a bottle of given wall thickness and initial temperature, the curing time may vary from 2 seconds in a low velocity air stream at 600°F to 0.1 second in the direct flame of a high temperature gas jet flame. Since the melt temperatures or cure temperature of many of the commonly used adhesives in heat transfer labels is above the deformation temperature of many of the commonly used bottle plastics, the preferred arrangement necessitates a very short exposure to a very high temperature heat source in order to take advantage of the high temperature gradient during the transient conditions of the heat flow through the low conductance materials of the label and the bottle, thus, it is desirable to obtain the required bottle surface temperature without raising the internal temperature of the bottle wall to the deformation temperature which would cause distortion when the bottle cools.

In general, the thermo-conductivity of the plactics bottle wall and the thermo-conductivity of the label will be approximately the same, and this will range from about 0.0002 (for certain styrene containing resins) to 0.0012 calories per second per square centimeter per centigrade degree (for certain high density polyethylenes). The plastics bottles or other plastics containers, which may be heat transfer labelled and then post-treated in acordance with the present invention, are molded in accordance with known procedures, primarily blow-molding, from the conventionally used plastics. Such plastics include acetal polymers and co-polymers (thermo-conductivity 0.00055 and heat distortion temperature 316—338°F) acrylic polymers such as polymethylmethacrylate (thermo-conductivity 0.00046, heat distortion temperature 150—210°F); cellulose esters such as cellulose acetate, cellulose propionate, cellulose acetate butyrate,

(thermo-conductivity between 0.0004 and 0.0008, heat distortion temperature 130—250°F); polyamides such as nylon 6 and nylon 6/6 (thermo-conductivity 0.0010 or greater, heat distortion temperature 360—360°F); polyethylene (thermo-conductivity 0.0008 through 0.00012, heat distortion temperature 105—180°F); polypropylene (thermo-conductivity 0.00028, heat distortion temperature 210—230°F); polycarbonate (thermo-conductivity 0.00046, heat distortion temperature 270—280°F); ABS resins, e.g. terpolymers and blends (thermo-conductivity 0.00046 through 0.00086, heat distortion temperature 165—225°F); other styrene polymers and copolymers (thermo-conductivity 0.0002 through 0.00033, heat distortion temperature 150—235°F) and various vinyl and vinylidene polymers and copolymers (thermo-conductivity 0.0003 through 0.0007, heat distortion temperatures 130—300°F).

Given the fixed condition of a label application run of the plastics from which the container is formed and its wall thickness, it is then a simple matter to control the degree of intense heat and the duration of exposure to provide a temperature gradient sufficiently high (1) to allow melting and reflow of the wax-like release coating for improved label appearance, (2) to permit the bottle surface to reach the temperature needed to obtain good label adhesion, i.e. label curing, and (3) without heating the bottle wall to the point where melting or distortion occurs.

When a direct flame is used for the post-treating operation of the present invention, it is generally desirable that the labelled bottle contact the direct flame for between 0.1 and 0.5 seconds. At lower flame temperatures, e.g. 500—800°F, longer dwell times may be necessary. When a hot air oven or a hot air knife is used, the temperature should be from 550—1500°F and the contact time from 0.25—3.0 seconds. As indicated above, however, the time-temperature sequence must be primarily regulated to prevent distortion in a plastic bottle and this is primarily dependent on the ratio between the label thickness and the bottle wall thickness, and it is also somewhat dependent upon the particular plastic from which the bottle is formed. Thus, the greater the wall thickness of the bottle and the higher the heat distortion temperature of the plastic, the more heat the container may receive without being distorted and thus the greater may be the duratoin of post-treatment or the greater may be the temperature of the air (if hot air is used) or flame or the closer the bottles may be to the radiant heater (if such is used).

The following examples illustrate, but do not limit the post-treatment procedure of the present invention.

Example 1

A series of preformed, high density polyethylene, thin-walled bottles having a distortion temperature of approximately 170°F was passed through separate zones for flame surface treatment, preheating, label applying and post-treating. Inflation pressure within the bottles was controlled at each individual zone. The particular bottles used had a wall thickness of about 3/32 of an inch and this was approximately eight times the thickness of the applied label. For each individual bottle processed, the bottle was first surface treated or flamed, as is conventional, and then inflated and preheated, and was then passed to the label applying zone under internal pressure where the label was transferred while heat was applied to the bottle. The bottle, supplied with an internal pressure of 0.5—0.7 pounds per square inch gauge was then moved through a gas flame having a temperature of about 3000°F in accordance with the present invention, the residence time of each bottle in the gas flame being approximately 0.1 second. The bottles were then cooled while maintaining the internal pressure of 0.5—0.7 pounds per square inch gauge. The resultant labelled bottles were found to be without defects.

Example 2

The same procedure as in EXAMPLE 1 was carried out except that immediately after the flame post-treatment, the bottles were passed through a refrigerated air blast to effect quenching. In this case, howver, no internal pressure was used after labelling. The resultant labelled bottles were without defects.

Example 3

The procedure of EXAMPLE 1 was again carried out except that the post-treatment step in accordance with the present invention comprises the passage of the bottles through an open-ended electric resistance radiant heater emitting energy in the 4.0 micron range. The degree of heat reaching the bottles passing through the heater could not be determined. The heat reaching the bottles is dependent not only upon the residence time of each bottle in the furnace, but also on the size of the coils, the material from which they are formed, the amount of current fed thereto, and the distance of the bottles from the coils. However, trial and error of a simple nature involving moving the coils toward and away from the bottle conveyor and increasing and decreasing the speed of bottle travel through the furnace provided the correct degree of heat in order to cure the label and remelt the released layer without effecting distortion in the bottles. Internal pressure was maintained during post-treatment. The bottles were without defect.

EXAMPLE 4

The procedure of EXAMPLE 1 was again carried out except that heat was applied in a hot air oven. The temperature within the oven was maintained at 600°F and each bottle was maintained in the oven for 2 seconds. The oven used in the Example required the batch deposition of the bottles and their batch removal, but a hot air oven can also be used in an intermittent process wherein the ends of the oven open and close, or in a continuous process wherein the ends of the oven are flexible so that the bottles can pass through these ends. Results were good.

EXAMPLE 5

The procedure of EXAMPLE 1 was again carried out except that the high intensity heat was applied with a hot air doctor with high velocity air at approximately 900°F. The bottles were in contact with the hot air jet or hot air knife for approximately 0.5 seconds. Results were good.

EXAMPLE 6

A preformed polymethyl methacrylate jar having a heat distortion temperature of 180°F and a wall thickness of 3/16 of an inch was passed through separate zones for preheating label applying and post-treating. The jar was relatively rigid and use of internal pressure was neither necessary nor desirable. After label application by the heat-transfer method, the jars were passed through the open flame of a gas jet at about 3000°F with a contact time of 0.2 seconds. Runs were made in which the so labelled and post treated jars were cooled under ambient conditions and other runs were made wherein the so post-treated jars were plunged into cold water for quenching, Results were satisfactory in both cases.

EXAMPLE 7

A preformed polypropylene bottle having a distortion temperature of about 215°F was labelled with the heat transfer label. A carrier paper made of 30 pound white machine-glazed kraft paper was coated with a wax type, partially oxidized polyethylene having a molecular weight of about 1400, a softening point of 101°C, a penetration hardness of about 3.5 and an acid number of about 14. The coating on the backing paper was applied at the rate of 10 pounds per ream.

The coated backing paper was then print coated with a protective layer using regular varnish etch cylinder 32 microns—150 line sereen— 15—20 wall with a wax-free vinyl acrylic lacquer.

The design print was then printed over the vinyl acrylic layer using red and blue chlorinated rubber resin ink.

Over the ink, as an overprint, there was then coated an adhesive layer comprising a solution of thermoplastic polyamide resin in lacquer form.

A decalcomania, formed as above, was then passed in face-to-face contact with a polyethylene bottle, the surface of which has been treated to render it more print receptive in a conventional manner, such as by flame contact or corona discharge. Heat and pressure were applied to the temporary backing to effect pressing of adhesion layer against the polyethylene. As the heat was applied, the polyethylene layer softened sufficiently to permit removal of the temporary backing. Simultaneously the adhesive overprint bonded to the polyethylene surface of the bottle. The temporary backing was stripped from the label with about half of the release layer remaining with the temporary backing and about half remaining with the label.

After cooling, the bottles so coated were tested to determine the adherence of the label thereto. The label was found to adhere tenaciously and to be abrasive resistant and also highly resistant to chemical action. Such heat transfer label was applied at a temperature of about 300°F while maintaining an internal pressure in the polypropylene of about 0.7 pounds per square inch gauge. The bottle thickness was approximately 1/16 of an inch. Immediately after labelling, the bottle was passed through an open flame of 3000°F, the dwell time being about 0.3 second. Quenching was not utilized. Results were good.

EXAMPLE 8

ABS terpolymer bottles, having a heat distortion temperature of 215°F and a wall thickness of about 1/16 of an inch were labelled at about 200°F with the heat-transfer label. A carrier paper made of 30 pound white machine-glazed kraft paper is coated with a slightly oxidized (saponification number of about 20) wax type polyethylene having a molecular weight of about 1400, a softening point of 103°C, a penetration hardness of about 4.0, an acid number of about 11 and a viscosity at 250°C of 225 centipoise. The coating on the backing paper is at the rate of 6 pounds per ream.

The wax coating backing paper is then print coated with a protective coating using regular varnish etch cylinder having a depth of 32—40 microns—150 line screen—15—20 wall with a wax-free vinyl acrylic lacquer.

The design print is then printed over the vinyl acrylic layer using alternative layers of nitrocellulose and polyamide inks.

Over the ink, as an overprint, there is then coated an adhesive layer comprising a solution of thermoplastics polyamide resin in lacquer form.

A decalcomania, formed as above, is then

passed in face-to-face contact with a polyethylene bottle, the surface of which has been treated to render it more print receptive in a conventional manner, such as by flame contact or corona discharge. Heat and pressure are applied to the temporary backing to effect pressing of the adhesive layer against the polyethylene. As the heat is applied, the polyethylene layer softens sufficiently to permit removal of the temporary backing. Simultaneausly, the adhesive overprint bonds to the polyethylene surface of the bottle. The temporary backing is stripped from the label with about half of the release layer remaining with the temporary backing and about half remaining with the label.

After cooling, the bottles so coated are tested to determine the adherence of the label thereto. The label is found to adhere tenaciously and to be abrasive resistant and also highly resistant to chemical action. The so-labelled ABS terpolymer bottles were then passed through an open-ended radiant heater, the dwell time of each bottle in the radiant heater being about 1.5 seconds. After some initial adjustment of the distance between the radiant heater and the bottles in the oven, the bottles could be passed through the oven to effect satisfactory curing of the labels thereon and without the necessity of any subsequent quenching.

It will be obvious to those skilled in the art that various changes may be without departing from the scope of the invention and the invention is not to be considered limited to the examples described in the specification.

WHAT WE CLAIM IS:—

1. A method of post-treating plastics containers to which a heat transfer label has been freshly applied, said label including an adhesive layer and an upper wax-like layer, comprising: applying intense heat to said labelled plastics container over a time period not in excess of 3 seconds, said intense heat effecting a cure of the adhesive of the label to the plastics bottle and also effecting a smoothing of the upper wax-like layer of the label; ending said application of intense heat before sufficient heat has been conducted through the wall of said plastics container to raise the inner surface of said plastics wall to the heat distortion temperature of said plastics and cooling said plastics container or permitting said plastics container to cool.

2. A method in accordance with claim 1 wherein said intense heat is applied by passing said plastics container through a flame and wherein the duration of said treatment is less than 1.0 second.

3. A method in accordance with claim 1 wherein said intense heat is applied by passing said plastics container through a radiant heater.

4. A method in accordance with claim 1 wherein said intense heat is applied by passing said plastics container in contact with heated air, and the temperature of said air is greater than 550°F.

5. A method in accordance with claim 4 wherein said heated air is in the form of an air knife.

6. A method in accordance with claim 1 wherein said cooling is effected by quickly quenching said container.

7. A method in accordance with claim 1 wherein said plastics container is supported during said post-treatment by internal gas of pressure less than one pound per square inch gauge pressure.

8. A method of post-treating plastics containers substantially as herein described with reference to any one of Examples 1 to 8.

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